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From: General Aviation Human Factors Program Manager, AAR-100
To: General Aviation TCRG

Subj: GENERAL AVIATION HUMAN FACTORS FOURTH QUARTER '03 REPORT

Ref: (a) General aviation human factors execution plans (http://www.hf.faa.gov/gafunded.htm)

1) Fourth quarter report for each project is listed below.

   a) Human Error and General Aviation Accidents: A Comprehensive, Fine-Grained Analysis using HFACS

   CAMI and University of Illinois researchers have continued their "fine-grained" analysis of aircrew errors associated with GA accidents, focusing on decision-errors, perceptual errors, and violations (the analysis of skill-based errors was completed last quarter). A report of the efforts this past FY was presented to the sponsors at the GA Program Review held in Reno, NV in September. In addition to this effort, a major investigation into human error associated with Alaskan GA accidents was completed this past quarter. Details follow:

   Comparison of Aircrew Errors Associated with Accidents Occurring in Alaska versus the Rest of U.S.

   Aviation in Alaska poses quite a challenge to those that frequent the Alaskan skies in comparison to the rest of the United States. Geographically, Alaska spans more than 2000 miles east to west and over 1000 miles north to south. Mountains, glaciers, lakes and long coastlines accentuate this terrain. In addition, dramatic changes in the weather often occur.

   With the combination of terrain and climate, aviators in Alaska are faced with highly demanding situations. In 2000 alone, pilots flying in Alaska were 3.5 times more likely to be involved in an accident than in the rest of the U.S. Unfortunately, the majority of past research has focused on the demographics of aviation accidents (e.g. age, gender, experience, medical condition, etc.), but few have focused on the human error component until recently.

At the request of AFS-801 (Anne Graham), CAMI researchers conducted a comprehensive human error analysis of Alaskan GA accidents using the Human Factors Analysis and Classification System (HFACS). In total, 15,546 accidents, associated with nearly 30,000 human causal factors, as reported by the National Transportation Safety Board (NTSB) were examined.

Results from these analyses revealed no major differences between Alaska and Rest of U.S. with regard to the overall pattern of human error (Figure 1). If anything, slightly more decision errors were associated with Alaska accidents along with fewer skill-based errors, perceptual errors, and violations. However, when looking deeper, differences were revealed in the specific types of errors and violations committed by those flying in Alaska. For example, with regard to specific types of decision errors, it appears that accidents in Alaska are twelve (12) times more likely to be due to taking-off or landing from/on unsuitable terrain (Table 1). Likewise, when examining specific skill-based errors, Alaskan accidents were almost two times as likely to be associated with a loss of directional control and almost three times as likely to involve inadequate compensation for wind conditions (Table 2). Finally, Alaskan accidents were nearly twice as likely to involve continued VFR flight into IMC weather (Table 3).

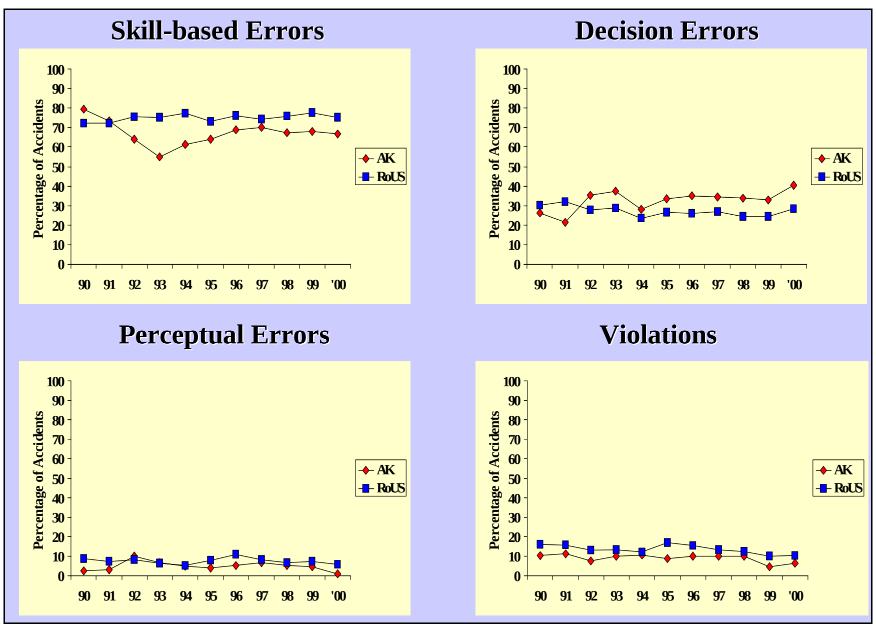

Figure 1. Percentage of accidents associated with skill-based errors, decision errors, perceptual errors, and violations occurring in Alaska and the rest of the U.S. (RoUS).

Table 1. Fine-grained analysis of decision errors for Alaska versus the rest of the U.S.

Error	Alaska	RoUS	Total
In-flight Planning/Decision	58 (14.1%)	857 (18.8%)	915 (18.4%)
Unsuitable Terrain	**159 (38.7%)**	**221 (4.8%)**	**380 (7.6%)**
Refueling	13 (3.2%)	321 (7%)	334 (6.7%)
Planning/Decision	20 (4.9%)	302 (6.6%)	322 (6.5%)
Go-around	16 (3.9%)	295 (6.%)	311 (6.3%)
Remedial Action	12 (2.9%)	280 (6.1%)	292 (5.9%)
Accidents with at least one Decision Error	411 (100%)	4560 (100%)	4971 (100%)

Table 2. Fine-grained analysis of skill-based errors for Alaska versus the rest of the U.S.

Error	Alaska	RoUS	Total
Directional Control	**187 (18.8%)**	**1806 (11.6%)**	**1993 (12.2%)**
Aircraft Control	51 (5.1%)	1227 (7.9%)	1278 (7.7%)
Airspeed	56 (5.6%)	1166 (7.5%)	1222 (7.4%)
Compensation for Wind Conditions	**145 (14.6%)**	**886 (5.7%)**	**1031 (6.2%)**
Accidents with at least one Skill-Based Error	993 (100%)	15512 (100%)	16505 (100%)

Table 3. Fine-grained analysis of violations for Alaska versus the rest of the U.S.

Violation	Alaska	RoUS	Total
VFR Flight into IMC	**27 (25%)**	**304 (13.8%)**	**331 (14.4%)**
Procedures/Directives	14 (13%)	244 (11.1%)	258 (11.2%)
Operating with Known Deficiencies	6 (5.6%)	234 (10.7%)	240 (10.4%)
Flight into Adverse Weather	10 (9.3%)	186 (8.5%)	196 (8.5%)
Fuel Supply	4 (3.7%)	163 (7.4%)	167 (7.3%)
Aircraft Weight and Balance	12 (11.1%)	127 (5.8%)	139 (6%)
Design Stress Limits of Aircraft	3 (2.8%)	118 (5.4%)	121 (5.3%)
Accidents with at least one Violation	108 (100%)	2195 (100%)	2303 (100%)

In addition to the human error results, additional analyses were conducted on some traditional demographic and accident variables like lighting conditions, weather, and controlled flight into terrain accidents. In short, there appeared to be no differences between Alaska and RoUS with regard to CFIT. However, there were more controlled flight into "terrain/water" for Alaska and more controlled flight into "obstacles" for the rest of the U.S. This result was not particularly surprising since there are more obstacles (power lines, towers, etc.) in the rest of the U.S. than there are in Alaska. With regard to lighting and weather, the majority of the accidents occurring in Alaska did so during daylight conditions, VMC weather, or a combination of the two. Finally, some good news, the percentage of fatal accidents was nearly three time fewer in Alaska than the rest of the U.S.

In sum, although there were significant differences in the overarching human error categories, the presence of very different types of errors and violations need to be addressed. It would appear from our comprehensive human error analysis that intervention strategies developed for pilots flying in Alaska should address the following issues:

- Takeoff and landing from/on unsuitable terrain
- Directional control
- Compensation for weather conditions and winds
- VFR flight into IMC
- Controlled flight into terrain/water

Publications/ Presentations FY03, Fourth Quarter

Shappell, S. and Wiegmann, D. (2003). Human Error Comparison of Military and Civilian Aviation Accidents using HFACS. Paper presented at the 111th Annual Meeting of the American Psychological Association, Toronto, Canada.

The researcher presented the FY03 annual report at the program review.

All indications indicate that this project is on track to complete the milestones as planned.

b) Comparison of the Effectiveness of a Personal Computer Aviation Training Device, a Flight Training Device and an Airplane in Conducting Instrument Proficiency Checks.

Between July 1 to September 30, 2003, seven pilots started the study. During this period of time, 43 pilots were scheduled for all types of sessions. A total of eleven pilots completed IPC#1 and ten pilots completed IPC#2, thereby completing the study. The following table shows the totals for this quarter:

Quarter Session Runs

Air-	PCATD-	Frasca-	IPC#1	IPC#2	P-	F-	A-	All	# of

fam*	fam*	fam*			Training	Training	Training	types:	Subjects Started
71	72	73	65	61	27	44	1	414	82

To date, 82 subjects started the study of which 72 are continuing or have completed the study. Of these 72 subjects started, 61 have completed the study. There are 37 subjects yet to be scheduled. As of September 30, 2003, a total of 414 sessions have been scheduled. A total of 65 pilots have completed IPC#1 and 61 pilots have completed IPC#2, thereby completing the study.

The researcher presented the FY03 annual report at the program review.

All indications indicate that this project is on track and will be completed in FY04.

c) Credit for Instrument Rating in a Flight Training Device or Personal Computer

i. Phase I: Survey UAA, Part 61, and Part 141 institutions.

Project completed. Report delivered to TCRG.

ii. Phase II: Capabilities of FTDs/PCATDs

A final report of the results was received and delivered to the sponsor (AFS-800) by the GA Program Manager (AAR-100, William 'Kip' Krebs, Ph.D.). This project is complete pending a possible final briefing (beyond what was briefed at the GA Program Review) of the results to sponsors in Washington.

Briefly, The purpose of this study was to reveal the types of training devices in use, how they are being used to enhance skill and proficiency, which tasks are being taught in these devices, whether or not the devices are appropriately certified and being used in accordance with National Simulator Program (NSP) guidelines, and if they are being used to augment training outside of approved training curricula.

This study targeted 184 schools that had indicated use of at least one training device in the study by Wiggins, Hampton, Morin, Larssen, & Troncoso (2002). Of the 184 schools targeted, 70 (38%) responded: 35 universities, 22 Part 141 schools, and 13 Part 61 schools. The study targeted training curricula for private pilot and commercial pilot certification and instrument and multiengine ratings. A survey was used to collect data in three primary areas: school demographics, device information, and tasks taught in training devices. In an attempt to standardize terminology, the Practical Test Standards (PTS) were used as the primary reference for the tasks taught. Common or similar Areas of Operations (AOO) from the four PTSs were combined in an attempt to have tasks listed only once. This resulted in 15 AOOs on the survey. Tasks from each PTS were placed under the most appropriate AOO. For each task, data were collected on the type of device used, for which certification level that task was taught, and on which learning domain the training was focused; knowledge, skill, or attitude (KSA).

Many schools, especially those in university-environments and FAA approved schools appear to be using both FTDs and PCATDs a significant amount. Part 61 schools do not seem to use these devices as much. The data suggests that training devices are used primarily in instrument training, but certainly not limited to that course. The data cannot address the question of whether or not the use of these devices reduces overall flight training time significantly. There appears to be some confusion about training device certification, both for initial certification and continuing use. Most schools felt their FSDO was helpful with the certification of their devices. The data suggests that some schools and/or instructors are experimenting with ways to gain more training value from these devices in courses other than instrument training. It might be helpful if some simple guidelines for device certification could be developed and distributed to all flight schools.

With respect to which tasks are being taught in FTDs, the majority seems to be in the area of instrument training. In most of the AOOs, instrument students show the highest use. A fairly sizable number of tasks were also being taught at the private pilot level. Slow Flight and Stalls is an example of an Area of Operation where private students outnumber students in all other courses. The task Steep Turns, in the Performance Maneuvers Area of Operation, is another. In the Ground Reference Maneuvers Area of Operation, there is some indication of use for private pilot training and, to a much lesser degree, in commercial pilot training. Whether or not the increasing number of high quality visual displays, that are on newer FTDs, is contributing to this is not known. But it is likely that as newer FTDs with better visual displays are used, training in visual flight maneuvers is likely to increase. This is a potential area for further research. FTDs do not appear to be used as much in commercial and multiengine training as they are in private and instrument training, with the exception of those tasks specific to multiengine training.

Looking at the data on KSAs taught in FTDs, there seems to be more emphasis on skills than on knowledge, and very little emphasis on attitudes or decision-making. It is possible that these devices may be unsuitable for attitude or decision-making training or that this area is overlooked or misunderstood by instructors. Since the focus of most training is on the accumulation of knowledge and the development of skills, it may be assumed that decision-making is simply part of those skills and is not looked upon as a separate issue. Airline training in the past decade has evolved to include decision-making and resource management as an integral part of their programs. While it is true that airline training is different from general aviation certification training, it might be worth exploring whether or not some concepts or techniques from airline training can be applied to general aviation.

The use of PCATDs tends to mirror FTD use in most of the AOOs. However, there are some notable exceptions. Takeoffs, Landings, and Go-Arounds is one such AOO. There are a small number of students who train the task Rectangular Courses in PCATDs. While this may seem meaningless on the surface, apparently at least one school believes that this training may be of some value. There are even a small number of students who train for multiengine tasks in PCATDs. In the teaching of KSAs in PCATDs, the data show similar trends as with FTD use, with the exception that in some instrument tasks, skills seemed to be emphasized more than knowledge.

Training aids show very little use in most Areas of Operations, with most of that use focusing on knowledge. However, the data show that some flight schools use these devices, so there may be some real value in their use. One factor that may be limiting the use of these devices by schools is that time in such devices cannot be used toward certification. It is not currently known how much students use programs such as Microsoft's Flight Simulator on their own and whether or not this contributes to success in training.

In summary, the data show that use of training devices are mostly in the instrument and private pilot training programs. The tasks are those involving airplane systems, navigation procedures and instrument flying. Some use is indicated in other tasks but to a much lesser degree. However, the fact that instructors are training students in tasks that are outside tasks related to instrument flying warrants attention and further investigation. Further controlled experiments are needed to address the question of whether or not flight training hours, and thereby costs, can be reduced by the use of FTDs and PCATDs in courses other than instrument training.

The researcher presented the FY03 annual report at the program review.

Project completed. Report delivered to TCRG.

iii. <u>Phase III: Transfer of Training Effectiveness of a Flight Training Device (FTD).</u>

A total of 5 students completed the AVI 130 Basic Instrument course for the spring semester and took the final check ride for the course. The following table shows the results of the check ride. A total of 4 students passed the check ride on the first attempt and 1 on the second attempt.

Lesson 45 Statistics (Summer, 2003)

	Airplane Only	PCATD 5.00	Frasca 5.00	Frasca 10.00	Frasca 15.00	Frasca 20.00
Number of Students	0	1	2	1	0	1
% First Flight Pass Rate	…. (N=0)	100 (N=1)	50 (N=1)	100 (N=1)	…. (N=0)	100 (N=1)
% Second Flight Pass Rate	…. (N=0)	…. (N=0)	100 (N=1)	…. (N=0)	…. (N=0)	…. (N=0)
Students Recommended 102	0	0	0	0	0	0
Total Dual to Completion	…. (N=0)	22.3 (N=1)	22.65 (N=2)	19 (N=1)	…. (N=0)	19.5 (N=1)
Variance Total Dual to Completion	…. (N=0)	…. (N=1)	2.21 (N=2)	…. (N=1)	…. (N=0)	…. (N=1)

Note: This lesson is the final check ride.

A combined total of 71 students completed the AVI 130 Basic Instrument course for the fall 2002, spring 2003,and summer 2003 semesters and took the final check ride for the course. Table 1 shows the results of the stage check. A total of 45 students passed the check ride on the first attempt and 25 on the second attempt. One student failed the check ride on the second attempt and was recommended for a remedial course, AVI 102. Five other students failed to complete the course and were recommended for AVI 102.

Table 1. Aviation 130 Combined Statistics
Lesson 45 Statistics (Fall, 2002, Spring, Summer, 2003)

	Airplane Only	PCATD 5.00	Frasca 5.00	Frasca 10.00	Frasca 15.00	Frasca 20.00
Number of Students	13	12	11	13	11	11
% First Flight Pass Rate	46.15 (N=6)	75.00 (N=9)	58.33 (N=7)	75.00 (N=9)	81.82 (N=9)	45.45 (N=5)
% Second Flight Pass Rate	100 (N=7)	100 (N=3)	100 (N=4)	100 (N=3)	50 (N=2)	100 (N=6)
Students Recommended 102	0	0	1	1	2	2
Total Dual to Completion	22.89 (N=13)	19.64 (N=12)	19.49 (N=11)	19.56 (N=12)	18.74 (N=11)	17.28 (N=11)
Variance Total Dual to Completion	10.69 (N=13)	7.65 (N=12)	7.25 (N=11)	7.95 (N=12)	5.60 (N=11)	10.92 (N=11)

Note: This lesson is the final check ride.

AVI 140

A total of 8 students completed the AVI 140 Advanced Instrument course for the summer semester and took the final check ride for the course. The following table shows the results of the check ride. A total of 6 students passed the check ride on the first attempt and 2 on the second attempt.

Lesson 60 Statistics (Summer 2003)

	Airplane Only	PCATD 5.00	Frasca 5.00	Frasca 10.00	Frasca 15.00	Frasca 20.00
Number of Students	2	2	1	1	1	1
% First Flight Pass Rate	0.00 (N=0)	100 (N=2)	100 (N=1)	100 (N=1)	100 (N=1)	100 (N=1)
% Second Flight Pass Rate	100 (N=2)	…. (N=0)	…. (N=0)	…. (N=0)	…. (N=0)	…. (N=0)
Students Recommended 102	0	0	0	0	0	0
Total Dual to Completion	29.80 (N=2)	26.10 (N=2)	26.20 (N=1)	27.00 (N=1)	22.60 (N=1)	17.50 (N=1)
Variance Total Dual to Completion	2.00 (N=2)	4.50 (N=2)	…. (N=1)	…. (N=1)	…. (N=1)	…. (N=1)

A combined total of 41 students completed the AVI 140 Advanced Instrument course for the spring 2003 and summer 2003 semesters and took the final check ride for the course. The following table shows the results of the check ride. A total of 24 students passed the check ride on the first attempt and 16 on the second attempt. Therefore 40 students have completed the study during the first year. The 6 students in AVI 140 for the spring semester who were recommended for AVI 102, a remedial course, fail to complete the course during the spring semester and therefore were not given an instrument rating flight check. This completion rate is consistent with projections.

Lesson 60 Statistics (Spring, Summer 2003)

	Airplane Only	PCATD 5.00	Frasca 5.00	Frasca 10.00	Frasca 15.00	Frasca 20.00
Number of Students	8	8	5	7	6	7
% First Flight Pass Rate	62.50 (N=5)	62.50 (N=5)	100 (N=5)	28.57 (N=2)	50 (N=3)	57.14 (N=4)
% Second Flight Pass Rate	100 (N=3)	100 (N=3)	…. (N=0)	100 (N=4)	100 (N=3)	100 (N=3)
Students Recommended 102	1	0	2	1	2	0
Total Dual to Completion	28.01 (N=8)	26.68 (N=7)	25.68 (N=5)	23.90 (N=6)	21.02 (N=6)	20.23 (N=7)
Variance Total Dual to	9.54	4.84	5.41	5.12	4.11	10.99

Completion	(N=8)	(N=7)	(N=5)	(N=6)	(N=6)	(N=7)

In summary, during this quarter five AVI 130 Basic Instruments students started the project for the summer semester and four AVI 130 Basic Instruments students completed the project for the summer semester. Forty students enrolled in AVI 140, Advanced Instruments, for the spring semester and forty successfully completed the course. Eight students enrolled in AVI 140, for the summer semester and eight successfully completed the course.

The researcher presented the FY03 annual report at the program review.

Indications are that this activity is on track.

d) Developing And Validating Criteria for Constraining False & Nuisance Alerts For Cockpit Display Of Traffic Information Avionics.

AAR-100 and AIR-130 provided additional guidance to the primary- and co-investigator to clarify what needs to be done. The co-investigator will now be responsible in delivering the final report. The co-investigator will actively participate in the project and coordinate with Dr. Dennis Beringer at CAMI to ensure the final document meets AIR-130's requirement. Overall, the project's direction has been refocused with the co-investigator and Dr. Beringer responsible in delivering the final deliverable.

The researcher presented the FY03 annual report at the program review.

Indications are that there are minor risks to the activity being completed as planned. A no-cost extension was authorized until December 31, 2003. The AIR-130 sponsor (Colleen Donovan) redefined the problem for the researchers.

e) Low Visibility and Visual Detection

The researcher completed the first phase of construction of the simulator (standard setup without extra visual graphics generation) and hired two graduate students to assist with the project. As specified in phase I of the execution plan, the researcher has collected approximately 250 images in the Reno area, the Los Angeles basin, Central and Northern California, Arizona, New Mexico, Texas, Louisiana, Florida, Idaho, Oregon, and Washington.

Indications are that this activity is on track.

f) Electronic Primary and Multi-function Flight Displays for GA; Certification Criteria and Usability Assessments.

A contract was let to Zedasoft, Inc., for modification of display software for the terrain-background PFD (ahead of milestone schedule in execution plan; task starts in FY ’04). Display mounting hardware was developed and tested in the AGARS and functioning of the display software in the HMD system as a panel mounted PFD (without attitude-reference symbology) was tested and verified (ahead of milestone schedule).

Fourth quarter 2003 new start. All indications indicate that this project is on track to complete year 1 milestones as planned.

g) <u>FAA/Industry Training Standards (FITS)</u>

No progress to report.

Fourth quarter 2003 new start grant. All indications indicate that this project is on track to complete year 1 milestones as planned.

William K. Krebs